**Teaching About Flying Foxes and Microbats: Science**

**About this teaching resource:**

The following are teacher resources that align with Year 8 to Year 10 Australian Curriculum Science. This is one of ten educational resources that provide detailed, teacher-friendly discipline content knowledge and pedagogical content knowledge for all discipline areas (Maths, English, Science, Humanities and the Social Sciences). The goal of these resources is to help teachers, who are already competent, experienced and skilled in teaching, develop the knowledge and confidence to increase awareness and build capacity of communities to understand and effectively live with local Microbats and Flying Foxes (FF), including the nationally vulnerable Grey-Headed Flying Fox (GHFF).

The teaching resources all offer student-centred, constructivist-based teaching suggestions and have been developed by teachers and overseen by a University academic who specialises in the teaching and learning of Science. Even though school-based education is identified as a key factor in building community capacity, there are few online educational resources promoting the teaching and learning of bats. Those that are available, rarely link to all discipline areas within the Australian Curriculum. Bats Qld believes that any formal education teaching resources must be directly linked to the National Australian Curriculum. This resource provides teacher and student friendly lesson suggestions and resources that directly link to the Australian Curriculum. This teaching resource mobilises expertise and knowledge of Flying Foxes and Microbats in relation to the latest Scientific and Statistical information and Health and Safety information. It improves awareness and understanding of the changing migratory paths of bats and offers support to Scientists' belief that Australian forests will only survive Climate Change with the help of Flying Foxes.

Because of their importance in Australia's ecosystems, and general misunderstandings within the populous, it is imperative that people are informed and well educated around Flying Foxes, so they can support the aim of finding the balance between reducing conflict associated with Flying Foxes roosting in urban areas, and the conservation and the conservation and welfare of these important native species.


**The purpose and structure of this teaching resource**

Education plays a significant and unique role in constructing public understanding and opinion about Bats, as well as informing policy. Therefore, we developed this teaching resource to support educators who would like to introduce 'Bats' (Flying Foxes and Microbats) to their students while teaching required aspects of the Australian Curriculum. Our goal is

to assist you with teaching suggestions: linked to the Australian Curriculum; that provide background Scientific information; that offer activity specific teaching resources; and that present a vast array of web-links all relating to the teaching and learning of Bats.
As you will see in our *Notes for Teachers* (below), Flying Foxes are considered by scientists to be a keystone species (one of the most important species in an ecosystem), and yet in Australian culture, Flying Foxes are misunderstood and vilified. Therefore, we developed these educational resources to promote scientific, as well as Health & Safety knowledge about Bats, and we invite students to challenge erroneous social stereotypes promoted in Australian media and wider society.

This educational resource is structured in the following way:

- An overview of each activity and their links to the Australian Curriculum (our curricular links are not definitive, as you may identify other Content Descriptors these activities are transferable to);
- Scientifically-based background *Notes for Teachers* about Flying Foxes and Microbats;
- A detailed outline of each activity that includes resources and discussion points to guide learning;
- An extensive online resource list; and Attachments of the printable resources suggested for the activities.

This teaching resource was developed by Australian teachers, for Australian teachers, and so we *do* understand that it can be difficult introducing controversial concepts into classrooms. We celebrate your commitment to ecological sustainability, and we stand beside you in your decision to advocate and education for change, not only for these important and wonderful mammals, but for wider Australian Ecosystem. Even though these teaching suggestions present factual information, we believe it is essential for students to emotionally connect with bats in order for them to be open to learning and making a difference. The following video illustrate how cute and wonderful Flying Foxes and Microbats are! We hope you enjoy this resource.

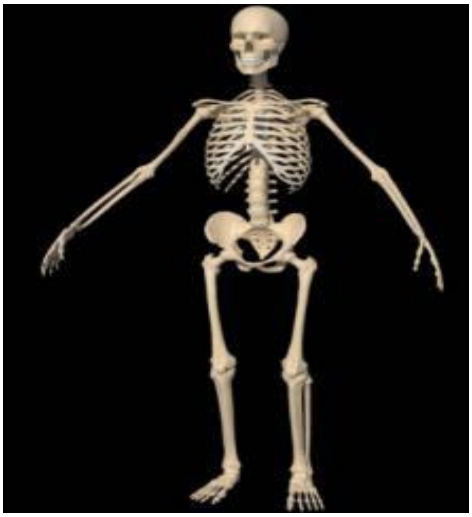
https://www.youtube.com/watch?v=T84jdO8YrYA https://www.youtube.com/watch?v=Uuvaos1WHTk
https://www.youtube.com/watch?v=T84jdO8YrYA https://www.youtube.com/watch?v=aMuWgN2DVD4
https://www.youtube.com/watch?v=Io3yl0OhTSY https://www.youtube.com/watch?v=2GncgfPNNms

**Project Leader and Head developer/writer:** Dr. Alison Sammel. *Please reference Dr Alison Sammel when using this material*. Please direct questions to: a.sammel@griffith.edu.au

Dr. Sammel would like to thank the Gold Coast City Council (for the K-10 curriculum) and the Logan City Council (the 11 & 12 curriculum) for supporting this project and the creative teachers who collaborated on the following teaching suggestions for every subject of the Australian Curriculum from Foundation Year to Year 10 and for selected subjects within the Year 11 and 12 curriculum. Thank you Merima Celahmetovic, Cherise Davis, Bonnie Gibson, Tara Hart and Carolyn Keepa.

**Notes for Teachers about Flying Foxes and Microbats**

For far too long, bats have instilled fear and inspired bad omens in many cultures around the world. Vilified in the media, these deeply misunderstood and misrepresented creatures are incredibly unique animals that play a vital role in Australia's ecosystem. In a world where attitudes towards sustainability are continuously changing and evolving, it is vital that students of today move away from misinformed historical stereotypes in order to develop a strong understanding and appreciation for this amazing creature, the only mammal capable of sustained flight.



There are over 1000 different species of bats worldwide. Bats are classified into two major groups: Flying Foxes and Microbats. Both share many similarities with humans: they have a similar skeletal structure (they have elongated fingers, not wings that they fly with), are warm-blooded, give birth and suckle their young, are devoted and caring mothers and even leave their children (called pups) at 'childcare' as they go in search of food! Most species can only give birth to one pup per year. Infants are carried everywhere by their mothers and suckled for up to five months.

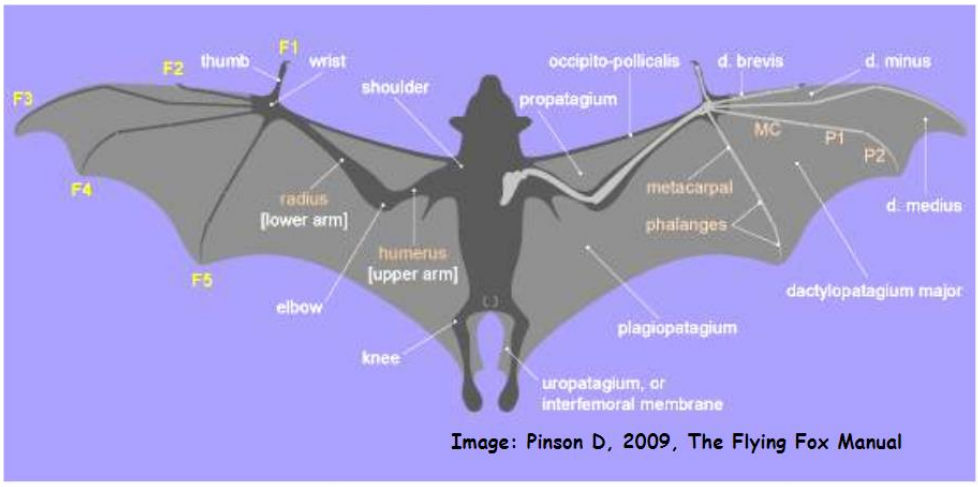
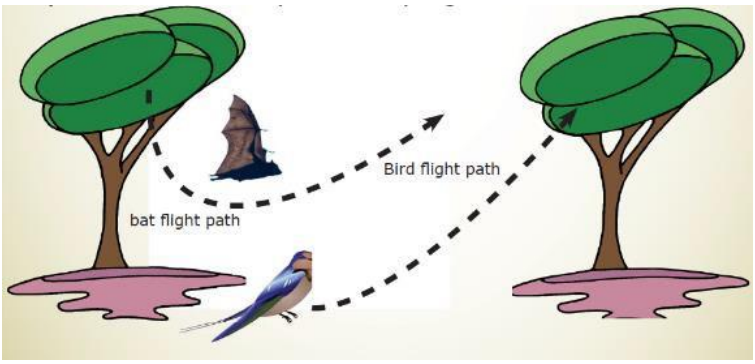


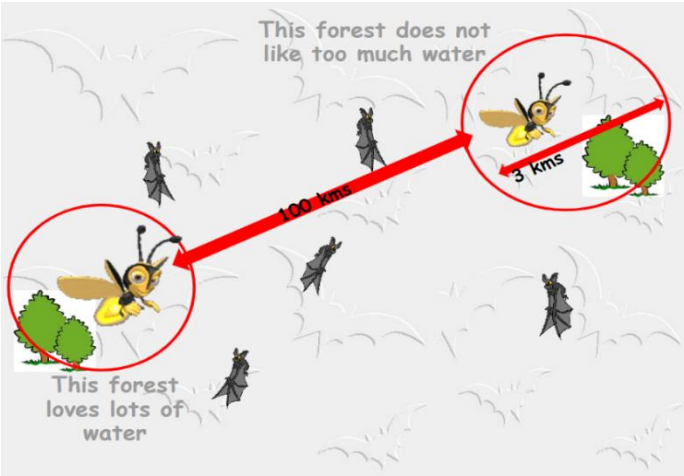

Image: Pinson D, 2009, The Flying Fox Manual

Bats are not aggressive animals. Bats do not ‘swoop’ or ‘attack’. If spooked, a bat will fly away but because they have hands and fingers rather than wings, they must drop or fall in order to catch the wind that will provide them with the lift necessary to sustain their flight.

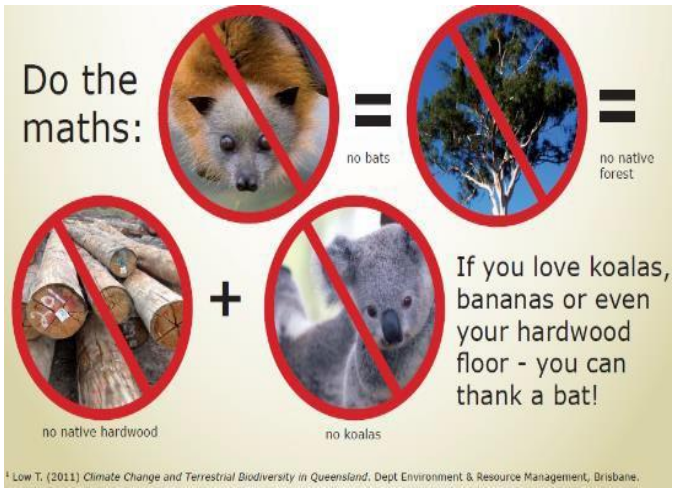



Flying Foxes or Megabats, are the largest sized bats (they also used to be known as Fruit Bats, but Flying Fox is the term that is used today). A Flying Fox has extremely good eyesight (the same as ours during the day and 25% better at night) and hearing and use these, and their strong sense of smell, to navigate the world. They are not blind and do not use echolocation. Flying Foxes are a keystone species in Australia meaning they are one of the most vital animals in our ecosystem. Flying Foxes play a key role in ensuring we have healthy coastal forests. Australian native trees reproduce by releasing and accepting pollen for fertilisation. After a flower on a tree is fertilised via pollination, the new genetic materials combine to produce seeds that then need to be distributed to other locations, away from the parent trees. Flying Foxes play an essential role in these processes. The study of science reveals that Flying Foxes and our native forests work together in an amazing and unique way that enhances the process of forest reproduction. Our native trees only release their flowers’ pollen at night, specifically for the Flying Foxes to pick up. Flying Foxes have the exact soft belly fur needed to collect and carry as much pollen as possible while they fly from flower to flower. As the Flying Foxes move from flower to flower, drinking nectar, they pass along the pollen they collect on their bellies. This process fertilises the plant’s flowers. Bees also do this role: however, as pollination occurs at night, Flying Foxes are more effective.

Furthermore, bees can only travel up to three kilometres and so cannot introduce new genetic material from other forest locations. The Flying Fox can travel over 100 kilometres per night and can fly from one forest to another, introducing new genetic material that will strengthen the resilience of the new generation of forests. Indeed, it is predicted that Australia’s forests will only survive climate change due to Flying Foxes introducing new genetic material to the next generation of



trees. For example, one forest might not like much water, and a bee will keep that gene pool the same, but a Flying Fox might fly from a forest that likes lots of water, 100 kilometres away, and introduce this new gene to the area. In doing so, the new generation of trees in that forest will be resilient to both drought or flood conditions.




Not only do Flying Foxes pollinate our native forests, they also eat the seeds from the fruit and disperse them to new areas so that the young trees can grow. Other animals do this, but a Flying Fox can digest the seed in a way that does not harm the seed, and when it is excreted, it can grow into a new plant. The process of chewing and digestion in other animals can ruin the seed, making it unviable for growth. A Flying Fox can distribute up to 3000 seeds in a single night! Their role as a keystone species means that Australian tree species, all Australian mammals such as koalas who seek shelter and food in these trees, Australian fruit trees and the Australian hardwood industry are all reliant upon the existence of the Flying Fox. In this way, humans are also dependent on Flying Foxes via the forests they sustain, as the forests supply us with oxygen, food and resources.

The second category of bat in Australia is the Microbat. This small bat plays an equally important role in the Australian ecosystem. Unlike the Flying Fox, the Microbat has extremely bad eyesight and relies on echolocation for travel and food. Microbats are insectivorous and can catch up to 500 insects per hour. The Microbats' incredible ability to consume large numbers of insects such as mosquitos and fruit flies means that life would be far less tolerable for both humans and plant species without them. It is interesting to know that Microbat boxes are being installed by universities, schools, farmers and the general public to reduce the use of pesticides within the environment and eradicate mosquito related diseases such as ross-river fever.

Considering the key role both Flying Foxes and Microbats play in Australia's ecosystem, it is unfortunate that the biggest threats to the species are habitat loss and ignorance and misinformation leading to poor human perception. People usually hold the misconception that bats carry lots of diseases. This is untrue. Science shows that there is only ONE disease that a human can catch from a bat: the Australian Bat Lyssavirus (ABLV). It is a form of rabies, but it is really, really rare. There have only been three reported cases in Australia. ABLV is very rare in the bat community, and most bats that contract this disease leave the colony and die within a few days. A person would have to be bitten by a bat within a small window of time (within those few days) to become infected. Therefore, the World Health Organisation considers it one of the rarest diseases on the planet! Contact with bat excrement, bat-eaten fruit, or having a bat fly above you will NOT transmit this disease. However, if bitten or scratched by ANY bat, all Australian government departments and bat groups strongly recommend people go to the hospital where they will receive a series of three post-bite injections (free of charge) that will ensure they do not get ABLV. There is no reason why any person should contract or die of ABLV as injections are available in Australia to stop this disease. If you do catch ABLV and do not receive the injections, you WILL die. It is important that students learn that if bitten or scratched by ANY animal, they must tell an adult, and if it is a bat, they should get the injections from the hospital.

It would be interesting to look at the Australian Bureau of Statistics to see the statistics associated with animal related deaths. This investigation would highlight that horses, cows, dogs and cats are dramatically more likely to cause human deaths than bats are. However, the most important message that students need to learn is: never touch a sick or injured bat, tell an adult if you get bitten or scratched by a bat and if you find a bat, it is best to notify your local bat (or animal) rescue and conservation organisation

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This summary was written by Dr. Alison Sammel. If you have any questions, please email a.sammel@griffith.edu.au

## Australian Curriculum (Science): Foundation

***Science Understanding:***

Biological Science: Living things have basic needs, including food and water (ACSSU002)

***Science as a Human Endeavour:***

Science involves observing, asking questions about, and describing changes in, objects and events (ACSSHE013)

***Science Inquiry Skills:***

Pose and respond to questions about familiar objects and events (ACSIS014) Engage in discussions about observations and represent ideas (ACSIS233) Share observations and ideas (ACSIS012)

**Teaching suggestions and links to the curriculum:**

In exploring this unit of biological science, foundation students will have discussed and responded to questions about the basic needs of humans (such as warmth, food and water). As a natural progression, teachers will often ask students about pets they may have at home and discuss how the needs of animals are similar or different to our own. The teacher may wish to discuss the types of foods pets eat and how it varies to the foods humans eat. Moving on from pets, the teacher may wish to discuss the needs of wild animals and how different animals may seek shelter, food or water in the wild. In raising awareness about Flying Foxes and Microbats, the teacher may wish to ask students what they know about bats. Do bats need food and water? What sorts of food do you think bats may eat? Where do bats sleep? Do they need warmth? Have students ever seen a bat or have they only ever seen them on television or in books? Teachers may ask students to draw a

picture of what they think bats may eat or what other needs they may have. Use this opportunity to make observations of student alternative conceptions of Flying Foxes and Microbats.


It is quite common for young students to have developed a negative image of bats through cartoons or even representations of bats during Halloween festivities. To build a more empathetic standing, it is a good idea to read books such as *Stellaluna* by Janell Cannon. Whilst reading the book, stop and make note of science concepts. Ensure students understand that Stellaluna is a Flying Fox. What needs does Stellaluna have? What sorts of food does Stellaluna like to eat? How did Stellaluna feel when she lost her mother and had to live with the family of birds? Did Stellaluna like eating the new food? Why did she eat
it? Relate students' personal experiences to those of Stellaluna's. Ask students if they have ever had to stay with another family like Stellaluna. Was everything different? How did it feel having to eat different food or sleep in a different bed?

As a class, make a list of the needs of Flying Foxes. Have students draw a picture of Stellaluna and her needs. Compare this drawing to students' earlier drawings. Have students share their two pictures with the class. How has their picture changed? What have they learned about Flying Foxes?

**Resources:**

- Cannon, J. (1993). *Stellaluna.* San Diego: Harcourt Brace Jovanovich
- YouTube Stellaluna read aloud by Pamela Reed www.youtube.com/watch?=VLRlvyWUzxs

Australian Curriculum Science (Foundation):

***Science Understanding:***

Earth and space sciences: Daily and seasonal changes in our environment affect everyday life (ACSSU004)

***Science as a Human Endeavour:***

Science involves observing, asking questions about, and describing changes in, objects and events (ACSSHE013)

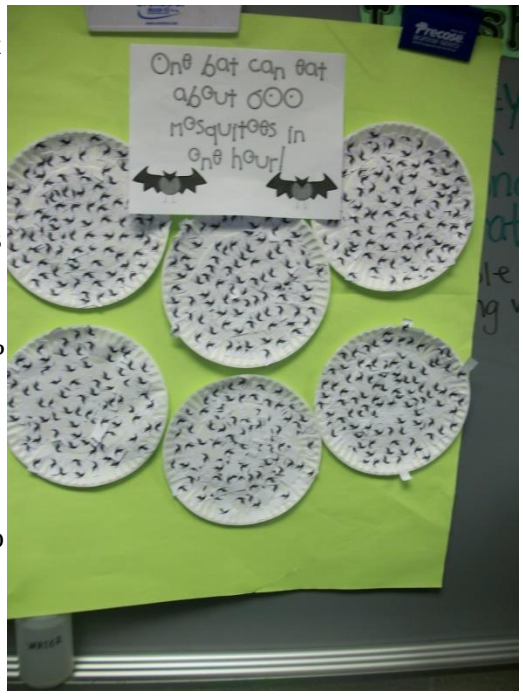
***Science Inquiry Skills:***

Pose and respond to questions about familiar objects and events (ACSIS014) Engage in discussions about observations and represent ideas (ACSIS233)
Participate in guided investigations and make observations using the senses (ACSIS011) Share observations and ideas (ACSIS012)

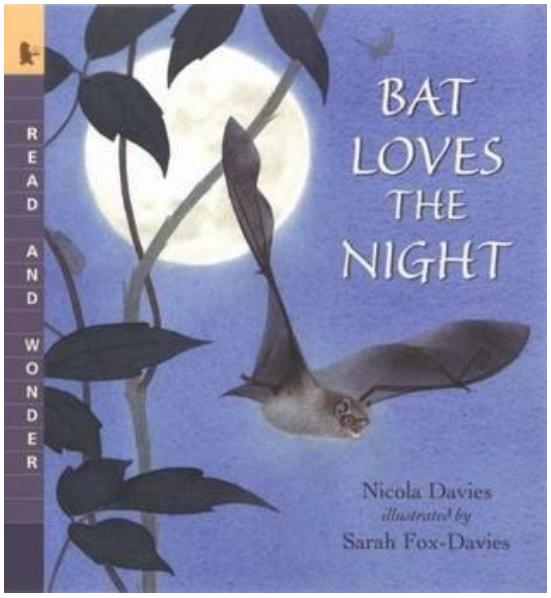
**Teaching suggestions and links to the curriculum:**

In this unit of Earth and Space sciences, students are linking the way in which animals - both humans and non-human animals - modify their behaviour or dress for different weather conditions. This is a great opportunity to make links to how all animals are similar and to discuss the way in which Flying Foxes will seek shade or water to keep themselves cool in extreme heat conditions. Allow students to use their senses to feel how different conditions or behaviours affect how hot or cool we may feel. Introduce a Flying Fox puppet to the class. Explain to students that the Flying Fox would like to visit the class often but needs to find a cool place to sleep or rest. Investigate different areas of the school where the puppet could rest. Have students stand in the direct sunlight, in shady places or near a fan. Have students feel the heat of a sunny patch of concrete versus a patch of concrete which is under the shade. Have students hold their hand in a bucket of water. Does this feel cooler? Ask students to draw a picture of where they think the puppet may wish to rest.

Once students have discussed their ideas, have students consider behaviours which Flying Foxes may use to keep themselves cool in warm weather. What are some things humans do to keep themselves cool? Discuss how we may seek shade, go swimming, fan ourselves and so forth. Have students view parts of the "Flying Foxes Vs Freshwater Crocodile" BBC YouTube clip. Whilst the narration of the video may be complex for young students, the teacher may choose to decrease the volume of the clip and discuss the images of the way in which Flying Foxes fan themselves, squabble for shade or swoop over water so as to keep themselves cool. Do students think Flying Foxes would behave in the same manner in cooler weather? Why or why not?




You may also be discussing the way in which humans and animals modify daily behaviour in reaction to day and night. This is a great time to discuss nocturnal animals including Flying Foxes and Microbats. Ask students what they know about bats and why they come out at night. Use this opportunity to discuss alternative conceptions which lead to a fear of Flying Foxes and Microbats. You may wish to discuss how just like some humans go to work at night time, bats will do the same.




Whilst Microbats help keep insect levels under control by hunting insects in the night, Flying Foxes play a hugely important role in helping to pollinate our native trees (all of which pollinate only at night time!). "Bat Loves the Night" by Nicola Davies is a great way to open up discussion surrounding this topic. The "Mrs Lewis Learning Library" blog suggests some great activities that can be incorporated alongside the study of this book. One suggestion to show just how important Microbats can be in controlling insect populations is by cutting out the amount of insects a bat can eat in one hour and gluing them onto the wall. These ideas and more can be found at http://lewislearninglibrary.blogspot.com.au/2011/10/halloween-projects-diary-of-bat- bat.html?m=1.

**Resources:**

- YouTube clip: Flying Foxes Vs Freshwater Crocodile – Lands of the Monsoon – BBC https://www.youtube.com/watch?v=wi30w-Mk2yQ
- Davies, N. (2001). *Bat loves the night.* Candlewick Press.

**Australian Curriculum (Science): Year One**

***Science Understanding:***

Biological Science: Living things have a variety of external features (ACSSU017)

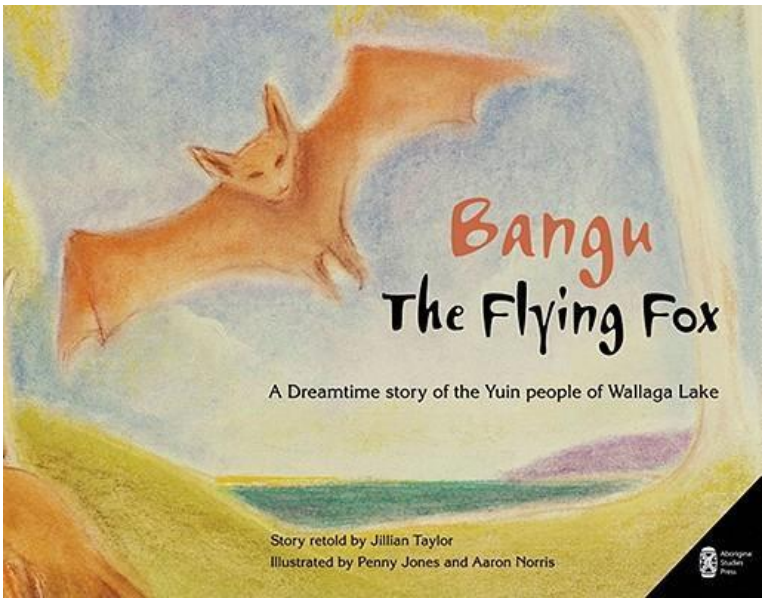
***Science as a Human Endeavour:***

Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021)

***Science Inquiry Skills:***

Pose and respond to questions, and make predictions about familiar objects and events (ACSIS024)

Represent and communicate observations and ideas in a variety of ways (ACSIS029)




**Teaching suggestions and links to the curriculum:**

In this unit of biological science, students are beginning to understand and explore the integral relationship between structure and function. As you begin to introduce students to the idea that all living things have a variety of external features, it is a great idea to engage students through picture books and even connections with Aboriginal and Torres Strait Islander cultures. You may choose to begin by reading the dreamtime story "Bangu the Flying Fox" as retold by Jillian Taylor. Use the book to discuss insights into Aboriginal culture and the moral message of friendship and loyalty. As Bangu could not decide if she was a bird or an animal, have students help Bangu determine what kind of animal she is. Use the "LabelMe" printout of a bat and discuss the external features Bangu has. Compare these external features to pictures and videos of birds and other mammals.

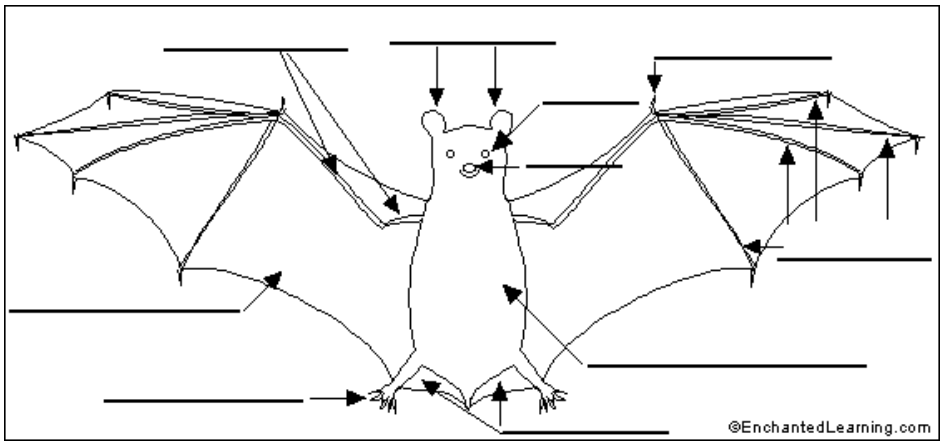

You may also choose to read "Stellaluna" by Janell Cannon with students to help students determine if a Flying Fox is similar to a bird. Have students discuss their observations in the class and write about them briefly in their interactive science notebooks.

You can find some wonderful "bat" interactive notebook suggestions for early years learners at the following web page: http://ericabohrer.blogspot.com.au/2015/10/bats-interactive-science- notebook.html

**Resources:**

- Taylor, J. (1994). *Bangu the Flying Fox: A dreamtime story of the Yuin People of Wallaga Lake.*
- Australia: Aboriginal Studies Press.
- (Further Bangu the Flying Fox curriculum suggestions can be found at: http://aiatsis.gov.au/sites/default/files/docs/asp/education/bangu-the-Flying Fox-teachers.pdf)
- Cannon, J. (1993). *Stellaluna.* San Diego: Harcourt Brace Jovanovich
- YouTube Stellaluna read aloud by Pamela Reed www.youtube.com/watch?=VLRlvyWUzxs

"Label Me" printout:



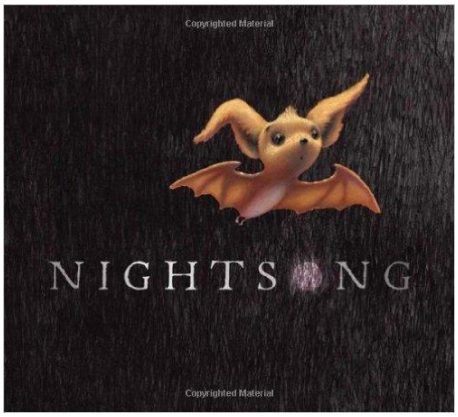

Retrieved from: http://www.enchantedlearning.com/subjects/mammals/bat/label/external/

**<u>Australian Curriculum (Science): Year One</u>**

***Science Understanding:***
Physical Sciences: Light and sound are produced by a range of sources and can be sensed (ACSSU020)

***Science as a Human Endeavour:***
People use science in their daily lives, including when caring for their environment and living things (ACSHE022)

***Science Inquiry Skills:***
Participate in guided investigations to explore and answer questions (ACSIS025)



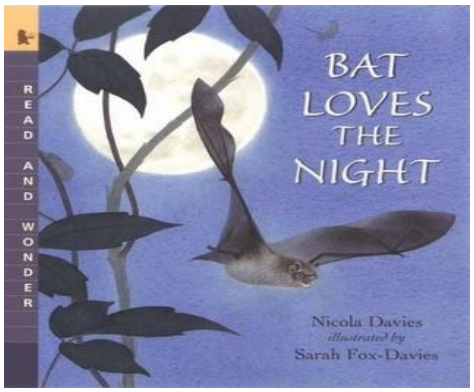

**Teaching suggestions and links to the curriculum:**

As students learn to understand that we "hear" sound, it is a great idea to explore the idea that both bats and humans can use sound to help them navigate around

objects when it is not possible to rely on vision. The topic can be introduced by reading "Night Song" by Ari Berk, a picture book which follows a small bat who discovers his echolocation sense for the first time. Use the story to spark discussion about how Microbats emit sounds which bounce off objects and return to them, helping them to measure the size or location of the object. It will be good to help students understand that not all bats use echolocation (Flying Foxes have keen eyesight, hearing and a sense smell). You may wish to mention to students that some people with vision impairments are learning to use echolocation to help them navigate when walking or even riding a bike. Details of this can be found in the Behind the News story at http://www.abc.net.au/btn/story/s3440826.htm ("Bat Man", 28/02/2012).

"Bright Hub Education" offers a suggestion for an experiment which will help students understand how sounds can bounce off objects before returning to us. They suggest setting up two cardboard tubes and an aluminium pie plate so that students can whisper into one tube whilst the other student listens through the other tube for the sound to bounce off the pie plate. Full details can be found at http://www.brighthubeducation.com/preschool-lesson-plans/106864- sound-and-vibration-science-activities-for-preschoolers/.

Bright Hub also suggests students play an echolocation game, which requires one blindfolded student to attempt to locate other students standing around him or her (please ensure the student is comfortable being blindfolded). The "bat" can make sounds such as a whistle or squeak, whilst the "insects" can reply by saying "buzz" or using a maraca to "rattle". The "bat" must try to catch an "insect" by using his or her sense of sound.




"Bat Loves the Night" by Nicola Davies is a more informational children's text which also details the way in which Microbats will use echolocation to navigate and catch insects. Students will also love learning the Jumpstart "Bat Echolocation" song which can be played and viewed on YouTube.

**Resources:**

- Berk, A. (2012). *Nightsong.* New York, NY: Simon & Schuster Books for Young Readers.
- Davies, N. (2001). *Bat loves the night.* Candlewick Press.
- YouTube video: "Jumpstart Bat Echolocation Song" https://www.youtube.com/watch?v=Hr-Y2Tt8gFE

**<u>Australian Curriculum (Science) Year Two:</u>**

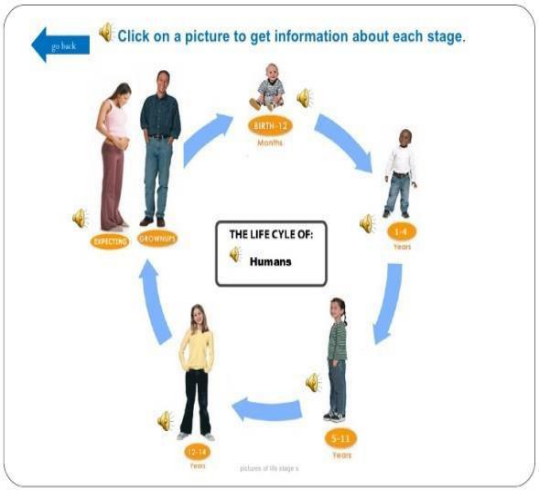
***Science Understanding:***
Biological Sciences: Living things grow, change and have offspring similar to themselves (ACSSU030)

***Science as a Human Endeavour:***
People use science in their daily lives, including when caring for their environment and living things (ACSHE035)

***Science Inquiry Skills:***
Participate in guided investigations to explore and answer questions (ACSIS038)

**Teaching suggestions and links to the curriculum:**

As students begin to develop an understanding of how and why living things grow, there is a great opportunity to develop empathy towards Flying Foxes and Microbats by exploring their life cycles. The book Stellaluna, by Janell Cannon, follows the beautiful story of a baby bat who is tragically separated from its mother at a very young age. This book is a great way to engage students in a discussion about how a Flying Fox's needs, abilities and physical appearance changes as it grows.



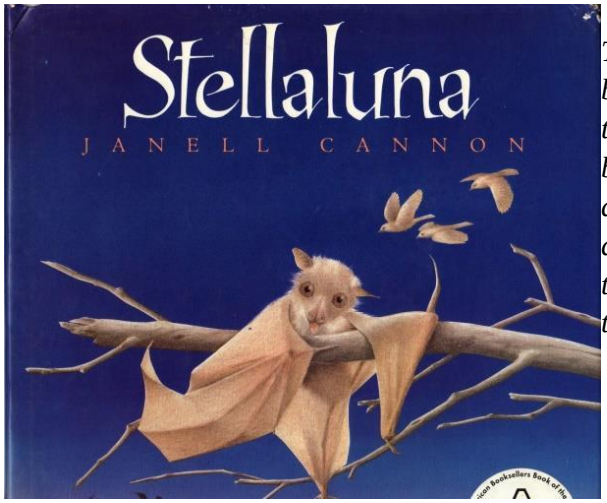

Expose students to the structure of a basic life cycle of a human being. Ensure you discuss the structure and function of each stage of development. Point out to students that at birth, they are unable to walk, talk

or eat on their own, however, as they grow, they learn to do these and become more independent. The life cycle depicted in the image above was found at http://www.slideshare.net/ebmorrison/morrisoneb-human-life-cycle. You may choose to use this image or another which better suits your students' levels of understanding.

After reading Stellaluna, allow students to develop a life cycle of the Flying Fox together as a class. A great resource to introduce the life cycle of Flying Foxes can be found on Page 6 of this Australian Government document - under the heading of Breeding: https://www.environment.nsw.gov.au/resources/animals/Flying Fox-2014-subs/flyingfoxsub- jenny-beatson-part3.pdf


Flying Foxes are mammals, just like us, and they progress through a similar life cycle.

*Flying Foxes only have one live young per year, which compared to other animals of their size, is a very low birth rate. The little red gives birth around April/May whilst the remaining three species give birth around October/November. The mothers carry their babies out each night to forage. The baby clings to the mother's underarm nipple with their mouths and hang onto her waist with their toes. They are carried by their mother for 4-5 weeks until too heavy to carry. The young is then left in the colony or the outlying trees of a colony and wait for their mother to return at dawn. They begin to fly at about 8- 10 weeks and feed independently by about 12 weeks.*




*The bond between mother and baby is very strong, mothers who lose their babies to predators while off foraging will search the place, they last saw their baby and continue calling for up to one week later. Females start breeding when they are about 15 months old. Males do not mature until around 3 years of age and they then form either paired or harem groups during the mating season. It is during this season that Flying Foxes tend to be the noisiest due to the defending of territories. It is also during this time that the campsite appears to emit the strongest odour due to secretions from the*

*male scent glands at his shoulders. He will rub this perfume on branches to mark his territory. The higher a male hangs in the tree and the smellier he is the more attractive he is to a mate (http://bats.org.au/about-bats/Flying Foxes.php)*

Baby Flying Foxes are reliant on an adult until they can fly and search for their own food. When their mothers leave them to find food, the young are looked after in a 'school' situation where the 2-3-year-old adolescent Flying Foxes will teach them about life in the colony.

Guide discussion by pointing out different stages of the life cycle within the book. Discuss why Stellaluna's mother was carrying her at the beginning of the book. Discuss how Stellaluna was reliant on someone to feed her when she was small. Discuss how Stellaluna learnt to fly later as she grew and how she learnt how to eat on her own. You may choose to have students develop their own Flying Fox life cycle in the interactive science notebooks. Some wonderful suggestions for this can be found at http://ericabohrer.blogspot.com.au/2015/10/bats-interactive- science-notebook.html.

It is a great idea to include a Science as a Human Endeavour link in this unit by discussing how humans can use their knowledge of the Flying Fox life cycle to help baby bats like Stellaluna who have been separated from their mother or even injured. Contact your local bat conservation and rescue organisation to obtain resources and information about how they raise and care for orphaned. Discuss with students how injured bats would be cared for differently depending on their developmental stage within their life cycle. Your students will love this link to real world situations. By conducting a Google or YouTube search of "Bat conservation and rescue", you will easily find a wide range of images, stories and videos to share with your students. Invite a member of a local bat group to come in and talk with the students, they might even bring a orphaned bat in for the students to meet.

Note: Now is a good time to ensure your students know what to do if they ever find a Flying Fox or Microbat who is in trouble. Students need to understand that their health and safety is paramount and that a bat should never be picked up with bare hands. If a bat is on the ground or on barbed wire, it can be covered carefully with a towel and rescue services should be contacted immediately. Students must know that if they are scratched or bitten by a bat, they should always tell an adult and they will need to go to the hospital to review a series of 3 post bite injections. Your local bat conservation organisation will have further information should you require it.

**Resources:**

- Cannon, J. (1993). *Stellaluna.* San Diego: Harcourt Brace Jovanovich
- YouTube Stellaluna read aloud by Pamela Reed www.youtube.com/watch?=VLRlvyWUzxs

**Australian Curriculum (Science) Year Four:**

***Science Understanding:***
Biological Sciences: Living things depend on each other and the environment to survive (ACSSU073)

***Science as a Human Endeavour:***
Science knowledge helps people to understand the effect of their actions (ACSHE062)

***Science Inquiry Skills:***
Represent and communicate observations, ideas and findings using formal and informal representations (ACSIS071)

**Teaching suggestions and links to the curriculum:**

When considering the elaborations of the abovementioned Biological Sciences content descriptor, deep connections can be formed through the study of Flying Foxes and Microbats. The Behind the News "Minibats" story (23 March 2010) is a great place to start. Click here for a link to the story. The page also includes a link to a Microbats information PDF developed by the Wildlife Preservation Society of Australia (http://www.australianwildlife.net.au/pdf/school/Microbats.pdf).

Below are suggestions on how each of the curriculum elaborations can be addressed through the discussion of Flying Foxes and Microbats:

Curriculum Elaborations:

Investigating how plants provide shelter for animals

**Teaching suggestions**

Discuss the different places Flying Foxes or Microbats may choose to roost. Discuss that whilst Flying Foxes will seek nourishment from the fruit or nectar of different trees, they will also seek shade in trees during extreme heat. An incredibly detailed example of how this occurs can be viewed in the BBC video "Flying Foxes Vs Freshwater Crocodile – Lands of the Monsoon". Please note, this shows scenes of crocodiles catching Flying Foxes and may upset some students. Please prepare them for this and why crocodiles would need to eat Flying Foxes.
Please also note that Bats (Flying Foxes and Microbats) all like and need the sun for vitamin D, just like us. However, as flying makes you very hot, and it is hotter during the day, bats fly at night to ensure they do not overheat. https://www.youtube.com/watch?v=wi30w-Mk2yQ

Introduce higher order thought processes by having students consider what could happen to Flying Foxes when their trees (food and shelter) are cut down. These trees are cut down so humans can use that land (build houses, farm etc). The trees and the land that is left for the Flying Foxes is usually the land we don't want (the area may be too hot, have little water, shade or breeze). If this is the only place the Flying Foxes can live, then when it gets really hot, they are usually trapped there (as it is too hot during the day to fly). If they can find shade in the trees, they can be fine, but if there is little shade, they move from the safe, top of the tree, to the lower levels of the tree where the air is cooler. The Flying Foxes will also stay on the shady side of the tree trunk. They will keep moving lower down the tree. If there is long grass (called an understory), this grass will shade them from the direct sunlight when they are at that level on the tree, and the cooler air will cool them down. But they are vulnerable to predators at this height. If there is no understory, the Flying Foxes will not be able to find shade or cool down during periods of extreme heat.

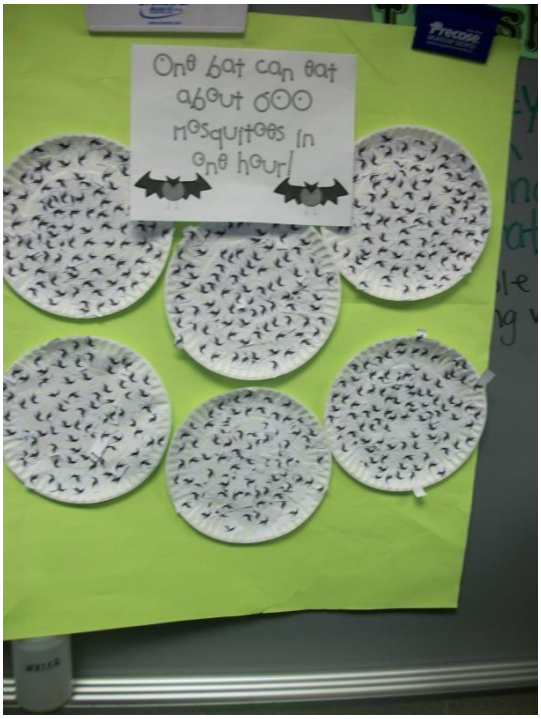
You may choose to share with your students the extent of the disaster which occurred in November of 2014 when over 5000 Flying Foxes died as a result of a heatwave. Use the information found at the following link to show how the shade plants provide is essential to these native Australian mammals (http://www.fourthcrossingwildlife.com/HeatStress- StanvicMcDonaldCollins.pdf or https://vimeo.com/86222807). Your local bat conservation organisation will have more details of the event. (Please note that there are 2 kinds of Bats - Flying Foxes and Microbats. It is important to model the correct use of terms, even if the videos do not).

Curriculum Elaborations:

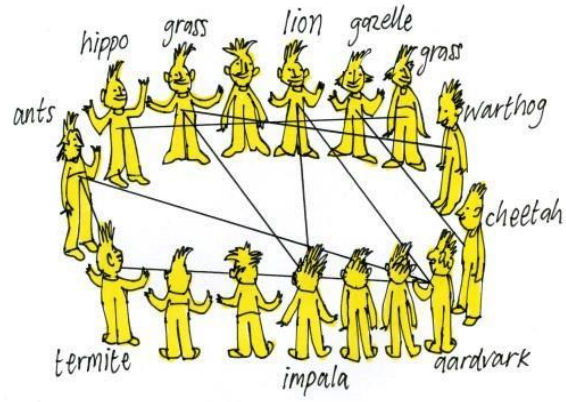
- Investigating the role of living things in a habitat, for instance producers, consumers or decomposers
- Observing and describing predator- prey relationships
- Predicting the effects when living things in feeding relationships are removed or die out in an area

**Teaching suggestions**

Have students research the important role Flying Foxes and Microbats play in Australian ecosystems. Ensure students understand that Flying Foxes are pollinators of native Australian trees which release their pollen only at night. Have students consider what would happen to koalas, bananas or even the Australian hardwood industry if we did not have Flying Foxes (who travel up to 100km each night) to pollinate these plants. A great video discussing this issue was commissioned by Flying Fox Rescue Release Noosa Inc. and can be found at https://vimeo.com/86222807. (Please note that there are 2 kinds of Bats - Flying Foxes and Microbats. It is important to model the correct use of terms, even if the videos do not).




Similarly, students can investigate the importance of Microbats in managing the effects of insects such as mosquitos. Have students consider the effects of pesticides versus natural pest control through the care for our Microbats. Physical representations of how many insects a Microbat can eat in an hour can be created for extra effect.




Each of the above, mentioned issues can be demonstrated to students through a food web string activity. By creating a physical food web using string within their class circle, students can see the effects of a trophic cascade if a particular animal ceased to exist. Details of the activity can be found at http://invigorate.royalsociety.org/ks3/life's- hidden-order/webs.aspx. Google search for an example of an Australian food web that include Flying Foxes for the students to use.

For a great resource see: http://flyingfoxcreaturefeature.blogspot.com.au/ (please note that this site states that Flying Foxes use echolocation, this is incorrect).

Curriculum Elaborations:

- Recognise that interactions between living things may be competitive or mutually beneficial.

**Teaching suggestions**

Have students explore the consistent battle between human beings and nature - specifically Flying Foxes and Microbats. How does our need to expand housing and urban development affect the habitat and population of Flying Foxes and Microbats? With their role in our ecosystem being such a critical one, can we afford to allow their numbers to deplete? Do we have a right to decide that our desire to expand cities is more important than their need for survival? There are many news articles which discuss these topics and you may choose to link this topic to an English unit of persuasive writing or debates. This is also a great opportunity to contact your local Indigenous elders who may offer a better insight into the mutually beneficial relationships that allow for better co-existence between humans and animals.

**Australian Curriculum (Science) Year Five:**

***Science Understanding:***
Biological Sciences: Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

***Science as a Human Endeavour:***
Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)

***Science Inquiry Skills:***
Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns and relationships in data using digital technologies as appropriate (ACSIS090)

**Teaching suggestions and links to the curriculum:**

In this unit of biological sciences, students are beginning to explore the idea that every species has its own set of structural features and behavioural adaptations which allow for its survival in its environment. This is a principle tenet of evolution which continuously spirals through the Australian Curriculum. The study of Flying Foxes and Microbats creates a strong platform in developing a deep understanding of scientific concepts such as structure, function and adaptations. For a good resource around this please see http://flyingfoxcreaturefeature.blogspot.com.au/ (please note that this site states that Flying Foxes use echolocation, this is incorrect).

With both Flying Foxes and Microbats often being commonly categorised as “bats” in general, it is a good idea to have students compare and contrast the structural features and behavioural adaptations of Flying Foxes and Microbats. In their investigations and analysis, students will find that whilst the two creatures may share some similarities (such as nocturnal behaviour), they have many differences.

Structurally, students will find that Microbats have large ears and small eyes which is perfectly coupled with its ability to use echolocation to navigate and catch prey. In contrast, students will find that Flying Foxes have much larger eyes and smaller ears, meaning they are able to rely on their sight and thus do not echolocate as Microbats do. Behaviourally, students will discover that Microbats will hibernate in winter months as a mechanism to conserve

energy when there are fewer insects about, although in the warmer Australian climates, Microbats may not fully hibernate. Flying Foxes, on the other hand, will fly great distances and move depending on the availability of their food.

By conducting a Google or YouTube search of Bat conservation and rescue groups, you will easily find a wide range of images, stories and videos to share with your students. Invite a member of a local bat group to come in and talk with the students, they might even bring a Flying Fox and Microbat in for the students to meet.

Remember, rather than purely passing this information on to students, have students make their own observations by exposing them to a rich range of video or imagery such as those shown below:

Behind the News offers a student friendly report about how Microbats are often misunderstood. The report can be found at the following link: https://www.google.com/url?q=http%3A%2F%2Fwww.abc.net.au%2Fbtn%2Fstory%2Fs284833 2.htm

The information in this report can also be coupled with the pdf Wildlife Preservation Society of Australia resource suggested by the site which is found at: (http://www.australianwildlife.net.au/pdf/school/Microbats.pdf)

The Victorian Government offers accurate and easy to understand information which students may be able to couple together with structural features and behavioural adaptations. This information can be found at: http://www.depi.vic.gov.au/environment-and-wildlife/wildlife/Flying Foxes/facts-about-Flying Foxes

The following YouTube videos can offer a great platform for observations of behavioural adaptations of Flying Foxes:

- Meet the world's biggest bat (National Geographic) https://www.youtube.com/watch?v=5FK9tWT5pA4
- Flying Foxes Vs. Freshwater Crocodile - Lands of the Monsoon - BBC https://www.youtube.com/watch?v=wi30w-Mk2yQ
- (Please note, this video includes imagery of crocodiles eating Flying Foxes, which some students may find distressing. You may choose to show the earlier parts of the video only which show the many

behavioural adaptations such as fanning, squabbling for shade or swooping above water so as to cool their body temperatures. Otherwise, you may choose to prepare students by making them aware of the scenes and discussing why the crocodiles need to eat the Flying Fox.

- The "Year 5: Adaptations of Flying Foxes" education kit also offers wonderful resources to use in the classroom. The kit can be found at:
- http://www.peekdesigns.com.au/wp-content/uploads/2014/03/AAB_Year5.pdf
- Remember to allow students the opportunity to record their findings in their interactive science notebooks. A Venn Diagram or T Chart would be a great way to show comparison of the two mammals

**Australian Curriculum (Science) Year Six:**

***Science Understanding:***
Biological Sciences: The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

***Science as a Human Endeavour:***
Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

***Science Inquiry Skills:***
Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

**Teaching suggestions and links to the curriculum:**

Year 6 achievement standards of the Australian Curriculum require students to describe and predict the effect of environmental changes on individual living things as well as explain how scientific knowledge helps us to solve problems and inform decisions. Whilst your students may be exploring the way in which many different plants and animals are affected by physical conditions of the environment, discussing the topic through lessons on Flying Foxes and Microbats allows for opportunity for students to apply their knowledge to local issues which are more than likely present in their local community. A simple search of recent media articles will uncover ongoing environmental issues which have resulted in a depletion of Flying Fox and Microbat populations, one which will no doubt face today's students for many years to come.

Prior to delving into such deep conversations, ensure students have a foundational understanding of the environmental conditions Flying Foxes and Microbats need in order to survive. You may wish to begin a KWL chart to establish what prior knowledge or even alternative conceptions students may hold as well as what students are eager to learn about the misunderstood mammals. Below is an example of a graphic organiser which students will find highly engaging. You can easily adjust headings to suit your classroom.
It would also be a great idea to insert the specific terminology in the centre of the poster (Flying Foxes or Microbats rather than just "bats").


Have students investigate and develop a strong understanding of the

environmental conditions within which Flying Foxes and Microbats will thrive. You may wish to discuss their habitat needs, their diet and their ideal climate. Ensure students understand that Microbats go into torpor (mild hibernation) in winter so as to conserve energy when there are fewer insects present in the environment. Likewise, it is important for students to understand that Flying Foxes are just as sensitive to extreme heat as we are. Just as we do, Flying Foxes will seek cool, shady places and water when temperatures rise in the summer months.

You may wish to read through the "Cool Facts About Bats" information sheet with your students. You can find this (and many other resources) at http://ausbats.org.au/cool-facts- about-bats/4569172153

Your students may also wish to explore the information posted by the Victorian Government at: http://www.depi.vic.gov.au/environment-and-wildlife/wildlife/Flying Foxes/facts-about-Flying Foxes

Once students have a clear understanding of the environment within which a Flying Fox or Microbat will survive, guide students in developing inquiry questions such as "what would happen if a Flying Fox could not find shade or water during extreme heat?" or "what would happen if a Microbat did not find a place where it could safely roost or hibernate?"

Your students may choose to investigate what could happen to Flying Foxes when their trees (food and shelter) are cut down. These trees are cut down so humans can use that land (build houses, farm etc). The trees and the land that is left for the Flying Foxes is usually the land we don't want (the area may be too hot, have little water, shade or breeze). If this is the only place the Flying Foxes can live, then when it gets really hot, they are usually trapped there (as it is too hot during the day to fly). If they can find shade in the trees, they can be fine, but if there is little shade, they move from the safe, top of the tree, to the lower levels of the tree where the air is cooler. The Flying Foxes will also stay on the shady side of the tree trunk. They will keep moving lower down the tree. If there is long grass (called an understory), this grass will shade them from the direct sunlight when they are at that level on the tree, and the cooler air will cool them down. But they are vulnerable to predators at this height. If there is no understory, the Flying Foxes will not be able to find shade or cool down during periods of extreme heat.

You may choose to share with your students the extent of the disaster which occurred in November of 2014 when over 5000 Flying Foxes died as a result of a heatwave. Use the information found at the following link to show how the shade plants provide is essential to these native Australian mammals (http://www.fourthcrossingwildlife.com/HeatStress-StanvicMcDonaldCollins.pdf or https://vimeo.com/86222807). Your local bat conservation organisation will have more details of the event. (Please note that there are 2 kinds of Bats - Flying Foxes and Microbats. It is important to model the correct use of terms, even if the videos do not).

Ensure students link this knowledge in an authentic manner by having students consider the effects of human activity on the Flying Foxes or Microbats in your local community. The ABC aired an interesting report through "Catalyst". The report discusses the way in which humans are attempting to eradicate and move colonies of "nuisance" bats. Contrary to most other reports, however, this report very cleverly quotes Dr Peggy Eby as stating that it would be far easier for us to manage and change our own behaviour than to change the behaviour of wild life. The report "In defense of the Flying Fox" can be accessed at: http://www.abc.net.au/catalyst/stories/3000668.htm

You may use this above quote to inspire discussion within your classroom. How can the human population promote positive co-existence with Flying Foxes and Microbats? This would be a great time to contact your local bat conservation group and/or Aboriginal or Torres Strait Islander Elder to offer insight into the issue. Think about ways in which your

students could communicate their knowledge and insights to other students within the school, or their local community. Students could work in conjunction with their local bat conservation group/ or environmental group to talk to the general public about the important role bats play in the ecosystem.

Ensure your students understand the ramifications of a depleting Flying Fox and Microbat population. You may wish to explore the No Me, No Tree campaign:

Sydney Wildlife Conservationists discuss the importance of Flying Foxes as a keystone species in our ecosystem: https://www.youtube.com/watch?v=e-KL9xmyU. Students will learn a lot from the educational information discussed in this video. They will also enjoy the adorable images of rescued Flying Foxes feeding on little bottles of milk - ensure your students understand that they should never handle an injured bat, but rather contact their local bat rescue organisation to care for the injured or orphaned bat as soon as possible.

Tim Pearson at TED X Canberra https://www.youtube.com/watch?v=qnOhS5jVBFk
(This video offers an entertaining insight into how Flying Foxes are actually a lot more like humans than we may have originally imagined)

This topic can also be easily linked with other Curriculum learning areas:

- English: Analyse news reports and discuss media bias. How and why are Flying Foxes and Microbats consistently represented in a negative manner in news stories? Create an authentic learning experience by having your students write a letter to a local councillor or an article in the school newsletter which discusses the importance of Flying Foxes and Microbats as a keystone species in our ecosystem.
- Design and Technologies: Have students design a roosting box which can house Microbats in and around the school. Can students design a safe netting which farmers can use to stop Flying Foxes feeding on the fruit of their orchids but does not entangle or endanger Flying Foxes?

**Australian Curriculum (Science) Year Seven:**

Please note: Whilst this lesson suggestion has been developed to align with the Year Seven achievement standards, the content covered can be easily adapted to align with the Year Nine content descriptor ACSSU176 (Ecosystems consist of communities of interdependent organisms and abiotic components of the environment, matter and energy flow through these systems). At this year level, you may wish to add to the suggestions below by discussing how heat stress events. Use the information found at the following link to show how the shade plants provide is essential to these native Australian mammals (http://www.fourthcrossingwildlife.com/HeatStress-StanvicMcDonaldCollins.pdf or https://vimeo.com/86222807).

***Science Understanding:***

- Biological Sciences: Interactions between organisms, including the effects of human activities can be represented by food chains and food webs (ACSSU112)

***Science as a Human Endeavour:***

- Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE119)
- Solutions to contemporary issues are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

***Science Inquiry Skills:***

- Summarise data from students own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)
- Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

**Teaching suggestions and links to the curriculum:**

In their study of food chains and food webs, it is vital that students begin to realise that all living things are part of a system in which they are all linked either directly or indirectly. By understanding this unity of interrelationships, students can begin to explore our ethical obligations as human beings to promote a healthy coexistence with other organisms rather than focusing on material gains which would impact greatly on our entire ecosystem.

The study of Flying Foxes and Microbats will offer a plethora of opportunities to discuss the abovementioned issues. Both Flying Foxes and Microbats are a keystone species within our ecosystem. Were these animals to be removed from our ecosystem, the trophic cascade which would eventuate would be detrimental.

It is vital that students understand that the Flying Fox is Australia's most important long-range pollinator. In contrast to the bee, who can travel only 3km per day, the Flying Fox will travel up to 100km per night, ensuring the long range spread of pollen from trees which pollinate only in the night. Their ability to do so ensures a great genetic diversity amongst trees, with the Flying Fox working to spread the genomes of trees from both flood prone areas and drought zones.

The result is the existence of trees which can survive Australia's harsh climatic variations due to its ability to tolerate both flood and drought.

Have students consider the effects on Australia's hardwood industry or banana plantations were these Flying Foxes unavailable to play this crucial role. What would happen to other native animals such as koalas if the Flying Fox was not available to pollinate the Eucalyptus tree?
There are many rich resources which promote the "No me, No tree" campaign which you may choose to share with your students. In the following video, Tim Pearson interestingly notes the dramatic effect which occurred in one society where the excessive use of pesticides resulted in the eradication of some pollinators. Human beings are now finding they must physically pollinate trees with little paintbrushes in order to ensure the survival of their trees.

No me, no tree: Tim Pearson at Ted X Canberra https://www.youtube.com/watch?v=qnOhS5jVBFk

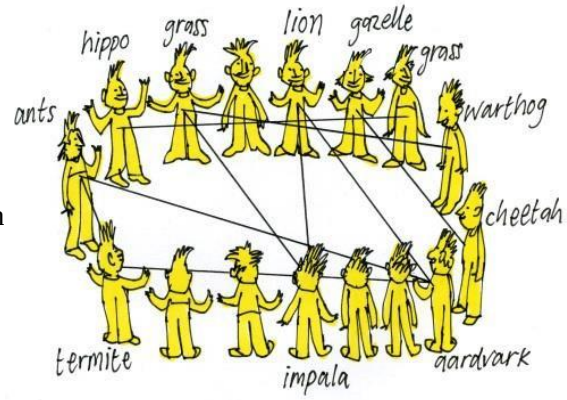
In Australia, bat rescue and conservation organisations are working very hard to help bats who have found themselves severely injured because of human actions. Contact your local bat conservation and rescue organisation to obtain resources and information about how they care for injured bats. Your students will love this link to real world situations. By conducting a Google or YouTube search of "Bat conservation and rescue", you will easily find a wide range of images, stories and videos to share with your students. Invite a member of a local bat group to come in and talk with the students,

they might even bring an injured bat in for the students to meet. Sydney Wildlife Conservationists also provide a good online resource to discuss the importance of Flying Foxes as a keystone species in our ecosystem: https://www.youtube.com/watch?v=e-KL9xmyU

(Please ensure your students understand never to touch an injured bat. If they are to see an injured bat, they must contact a local bat rescue organisation immediately).

Just like the Flying Fox, our Microbats play an important role in our ecosystem. With their ability to consume up to 600 mosquitoes per hour, the Microbat can play a huge role in pest control and the minimisation of diseases such as Ross River Fever. You may choose to share with your students the following article which shows how Griffith University is endeavouring to help reduce the incidence of Ross River Fever by installing homes for Microbats on its campus. (https://app.griffith.edu.au/news/2015/06/04/microbats-find-home-at-griffiths-new-car-park/).

Behind the News offers a student friendly report about how Microbats are often misunderstood. The report can be found at the following link:
https://www.google.com/url?q=http%3A%2F%2Fwww.abc.net.au%2Fbtn%2Fstory%2Fs284833 2.htm
The information in this report can also be coupled with the pdf Wildlife Preservation Society of Australia resource suggested by the site which is found at: (http://www.australianwildlife.net.au/pdf/school/Microbats.pdf).




Each of the above mentioned issues can be demonstrated to students through a food web string activity. “Luckyburke” offers a wonderful resource to teach about food webs and adaptations involving Flying Foxes. Please see the following site for great teaching suggestions:
http://flyingfoxcreaturefeature.blogspot.com.au/ (please note that this site states that Flying Foxes use echolocation, this is incorrect).
By creating a physical food web using string within their class circle, students can see the effects of a trophic cascade if a particular animal ceased to exist. Details of the activity can be found at http://invigorate.royalsociety.org/ks3/life's-hidden- order/webs.aspx. Google search for an example of an Australian food web that include Flying Foxes for the students to use.

The Australian Bat Society offers some very informative, student friendly information packs which you may choose to share with your students in their investigation of the abovementioned issues. The information packs and many other resources can be accessed at www.ausbats.org.au. It is important to note the “Australia’s Flying Foxes” information sheet which discusses approaches humans have used to control Flying Fox populations in the past and offers suggestions for better solutions which can be implemented in the future. Information such as this will provide a platform for inspiring discussions and authentic learning experiences.

Allow students the opportunity to investigate each of the abovementioned issues and present them to their class or even the wider school community. It is a great idea to incorporate the use of digital technology by allowing your students to create a campaign or informative video which educates their fellow students on the importance of Microbats and Flying Foxes in our ecosystem. Ensure your students support their claims with the scientific evidence they have gathered in their research.

Ask the student to think about how to promote animal friendly spaces in their local environment. Local bat groups will offer the statistics about how many rescues they do and how fruit netting tends to be the number one urban rescue call. Ask students to explore why bats and other animals get caught in fruit netting. Investigate how animal friendly fruit netting works (see http://www.animalsaustralia.org/issues/Flying Foxes.php), i.e. safe netting: You cannot poke your finger through safe netting — the holes are too small. Any netting you CAN'T poke your finger through is safe for Flying Foxes and other animals.

**Australian Curriculum (Science) Year Ten:**

Note: This lesson suggestion incorporates ideas which can be used within three different Science Understanding content descriptors. It is unrealistic to teach all three elements within one unit; however, elements of the following information can easily be incorporated to enrich elements of your chosen units.

***Science Understanding:***

- Biological Sciences: Transmission of heritable characteristics from one generation to the next involves DNA and genes (ACSSU184)
- Biological Sciences: The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence (ACSSU185)
- Earth and Space Sciences: Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere (ACSSU189)

***Science as a Human Endeavour:***

- People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE194)
- Values and needs of contemporary society can influence the focus of scientific research (ACSHE230)

***Science Inquiry Skills:***

- Critically analyse the validity of information in primary and secondary sources, and evaluate the approaches used to solve problems (ACSHE206)

**Teaching suggestions and links to the curriculum:**

In their earlier interactions with the characteristics of living things, students will have explored the idea of "MRS GREN" and that to be categorised as "living" an organism must meet seven vital criteria: movement, respiration, sensitivity, growth, reproduction, excretion and nutrition. By year 10, however, students should be exploring three further points, including that all living organisms are composed of at least one cell, that all living organisms store genetic information which controls the way the organism develops and that all living things evolve over time in response to their environment.

The study of Flying Foxes and Microbats can provide a fascinating insight into the abovementioned factors, particularly genetic code and evolution. Once your students have a grasp of the underlying theories of genes, DNA and evolution, it is vital to allow them to elaborate their learning by applying their learning to new situations which can develop deeper understanding of concepts and skills. Extend and expand their knowledge by discussing how the study of genes, DNA and even evolution has and can be used to further improve the quality of human life.

Help build students' scientific literacy by presenting them with the research led by Dr Emma Teeling who studies evolutionary unique animals to enhance man's understanding of his own genome. Dr Teeling dedicates her time and knowledge to attempt to answer questions such as "Why do bats live as long as they can when they shouldn't live for as long as they do?" Her research can show students that scientific knowledge and advances in science can greatly affect people's lives.

You may wish to investigate and discuss with your students some of the "questions" Dr Teeling is infatuated by. In her presentation on "Light and Shadow", Dr Teeling notes that "bats" have evolved to perform extremely well in complete darkness. As a result, their species has become quite a successful group, with 1/5th of all living mammals today being "bats". Explore this idea with your students by investigating how Microbats and Flying Foxes have evolved over the past 55 million years and what factors have led to the success of their species.

The abovementioned video can be accessed at https://www.youtube.com/watch?v=2LHUNLkmwbc. Dr Teeling not only discusses the idea that different "bats" have evolved to use different types of echolocation, but also notes how humans have reacted to the scientific studies of echolocation. She further points out how understanding the evolution of bats can allow humans to analyse their genes so as to overcome issues such as blindness and even aging. These issues are further noted in Dr Teelings Ted X Dublin talk "The secret of the bat genome" which can be accessed at https://www.youtube.com/watch?v=AHcTWlxWzpE (Please note: It is important to note that whilst Dr Teeling refers to "bats" and sometimes even "fruit bats", students should understand the correct use of terms are Microbats and Flying Foxes).

Another interesting point you may choose to investigate with your students is made by Dr Teeling in the video "Bats and their evolution" (https://www.youtube.com/watch?v=0nqYi7ydEzg). Dr Teeling notes that through her study of population genetics, she is able to study the effects of issues such as habitat fragmentation and climate change on a particular species of Microbats. These studies will not only enable humans to better understand the evolution of Microbats and Flying Foxes, but also help us to understand how issues such as climate change may affect further evolutionary changes in the species. In her studies, Dr Teeling has uncovered a relationship between "hot house" gasses and the evolution of the Microbat. Dr Teeling interestingly notes that 52 million years ago, the instance of Microbats increased as a result of a seven degree increase in the Earth's temperature which resulted in a major increase in insects and plants. Have students investigate what effects a further rise in the Earth's temperature with climate change may have on not only Microbats, but also Fruit Bats. You may wish to explore extreme heat stress events of recent times and their impacts on Flying Foxes (https://www.google.com/url?q=http%3A%2F%2Fwww.fourthcrossingwildlife.com%2FHeatStres s-StanvicMcDonaldCollins.pdf).

Dr Teeling has developed a very comprehensive website which details the research her team has undertaken and the publications of this research (http://batlab.ucd.ie/). It would be a great idea to incorporate the use of digital technology here by perhaps organising digital communication with Dr Teeling or a member of her research team. Have students develop questions or share their ideas with Dr Teeling via email or even Skype.

**Australian Curriculum (Design and Technologies) Years Three to Ten:**

Note: Although it may seem odd that this lesson suggestion is written for a very broad age group, the nature of the Design and Technologies curriculum and the suggestion itself allow for the tailoring of ideas to suit particular achievement levels. Through scaffolding and differentiation, the lesson can easily be adjusted to suit any of the above year levels.

**Years 3 and 4:**

***Knowledge and understanding:***

- Recognise the role of people in design and technologies occupations and explore factors, including sustainability that impact on the design of products, services and environments to meet community needs (ACTDEK010)
- Investigate the suitability of materials, systems, components, tools and equipment for a range of purposes (ACTDEK013)

***Processes and production skills:***

- Critique needs or opportunities for designing and explore and test a variety of materials, components, tools and equipment and the techniques needed to produce designed solutions (ACTDEP014)
- Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques (ACTDEP015)
- Select and use materials, components, tools, equipment and techniques and use safe work practices to make designed solutions (ACTDEP016)
- Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment (ACTDEP017)
- Plan a sequence of production steps when making designed solutions individually and collaboratively (ACTDEP018)

**Years 5 and 6:**

***Knowledge and understanding:***

- Examine how people in design and technologies occupations address competing considerations, including sustainability in the design of products, services, and environments for current and future use (ACTDEK019)
- Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use (ACTDEK023)

***Processes and production skills:***

- Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions (ACTDEP024)
- Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (ACTDEP025)
- Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions (ACTDEP026)
- Negotiate criteria for success that include sustainability to evaluate design ideas, processes and
- solutions (ACTDEP027)
- Develop project plans that include consideration of resources when making designed solutions individually and collaboratively (ACTDEP028)

**Years 7 and 8:**

***Knowledge and understanding:***

- Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures (ACTDEK029)

- Analyse ways to produce designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment (ACTDEK034)

***Processes and production skills:***

- Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas
- (ACTDEP035)
- Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques (ACTDEP036)
- Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions (ACTDEP037)
- Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability (ACTDEP038)
- Use project management processes when working individually and collaboratively to coordinate production of designed solutions (ACTDEP039)

**Years 9 and 10:**

***Knowledge and understanding:***

- Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040)
- Investigate and make judgments on how the characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions (ACTDEK046)
- Investigate and make judgments, within a range of technologies specialisations, on how
- technologies can be combined to create designed solutions (ACTDEK047)

***Processes and production skills:***

- Critique needs or opportunities to develop design briefs and investigate and select an increasingly sophisticated range of materials, systems, components, tools and equipment to develop design ideas (ACTDEP048)
- Develop, modify and communicate design ideas by applying design thinking, creativity, innovation and enterprise skills of increasing sophistication (ACTDEP049)
- Work flexibly to effectively and safely test, select, justify and use appropriate technologies and processes to make designed solutions (ACTDEP050)
- Evaluate design ideas, processes and solutions against comprehensive criteria for success
- recognising the need for sustainability (ACTDEP051)
- Develop project plans using digital technologies to plan and manage projects individually and collaboratively taking into consideration time, cost, risk and production processes (ACTDEP052)

**Teaching suggestions and links to the curriculum:**

Through the Design and Technologies curriculum, students are using critical and creative thinking to consider how solutions that are created now can and will be used in the future. A portion of the curriculum requires students to consider and develop solutions to meet and impact upon liveability and environmental sustainability.

As mentioned in the notes for teachers above, farmers and conservationists are installing bat boxes so as to encourage the growth of Microbat numbers in their local area. As Microbats consume large numbers of insects in each nightly feed, it is hoped that the need for pesticides or the incidence of diseases such as ross-river fever will decrease significantly. An example of this can be found in the following news article: (https://app.griffith.edu.au/news/2015/06/04/microbats-find-home-at-griffiths-new-car-park/). You may choose to integrate this knowledge with Science content or introduce the topic to students exclusively through the Design and Technologies curriculum.

It would be a great idea to have your students design and build bat boxes which could be installed in and around the school so as to attract Microbats. The Australian Bat Society provides some great information on how to build a bat box (http://ausbats.org.au/install-a- microbat-house/4582876246) and also offers a fact sheet which lists specifications, requirements and further instructions (http://ausbats.org.au/bat-boxes/4569171999).

Depending on the age or achievement standards of your students, you may choose to scaffold the design and construction process. For younger students, provide a list of specifications and restrict the range of materials they can use. For older or more advanced students, allow them to create their own designs and consider which materials would best suit weather conditions and requirements of the Microbats. Have students design a prototype and actualise the project by organising to have the best prototype built and installed in and around the school.

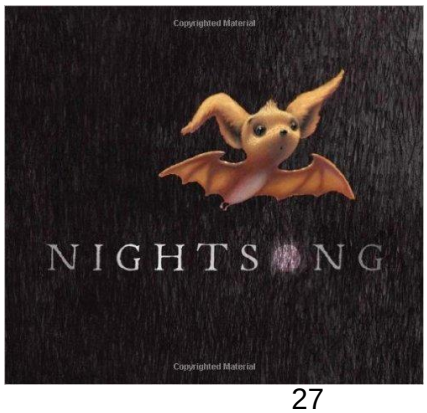
In doing so, further learning can continue to take place. Consider the way in which students at Pallara State School have had the opportunity to monitor Possums who seek shelter in similar boxes installed in trees near the school. Details of the project can be viewed at the Teaching Teachers for the Future Website (http://www.ttf.edu.au/show-video.html?resid=1383 "Possum Magic: Embedding Technology in Deep Learning). With the technology in place, teachers are given endless opportunity to develop learning experiences surrounding Science, Digital Technologies and even Mathematics. More importantly, however, students are so engaged by the experience that they do not realise that they are learning.

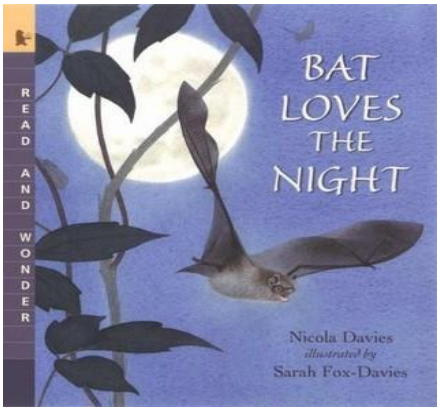
The following books could be used to engage younger students with bats just like Pallara State School did with possums:


Cannon, J. (1993). *Stellaluna.* San Diego: Harcourt Brace Jovanovich

Youtube Stellaluna read aloud by Pamela Reed
www.youtube.com/watch?=VLRlvyWUzxs

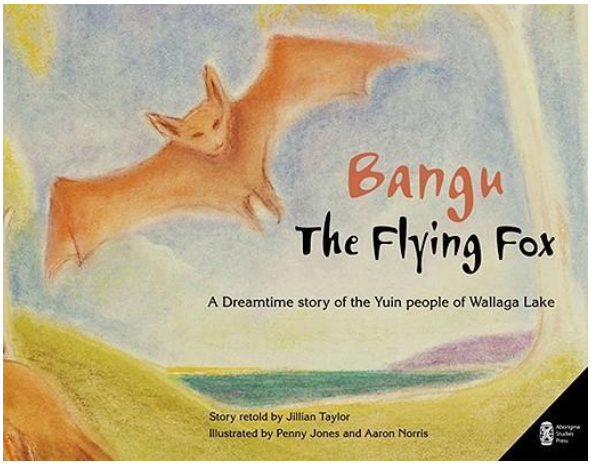
Berk, A. (2012). *Nightsong.* New York, NY: Simon & Schuster Books for Young Readers.






Davies, N. (2001). *Bat loves the night.* Candlewick Press.Taylor, J. (1994). *Bangu the Flying Fox: A dreamtime story of the Yuin People of Wallaga Lake.* Australia: Aboriginal Studies Press.

(Further Bangu the Flying Fox curriculum suggestions can be found at: http://aiatsis.gov.au/sites/default/files/docs/asp/education/bangu-the-Flying Fox-teachers.pdf)




Additionally, you may choose to investigate solutions for a common problem with wildlife and fruit netting in cities. Ask the student to think about how to promote animal friendly spaces in their local urban environment. Local bat groups will offer the statistics about how many rescues

they do and how fruit netting tends to be the number one urban rescue call. Ask students to explore why bats and other animals get caught in fruit netting. Investigate how animal friendly fruit netting works (see http://www.animalsaustralia.org/issues/Flying Foxes.php), i.e. safe netting: You cannot poke your finger through safe netting — the holes are too small. Any netting you CAN'T poke your finger through is safe for Flying Foxes and other animals. Investigate why this netting is safe for animals, how it could be promoted over unsafe animal netting.

**Australian Curriculum (Digital Technologies) Years Three to Six:**

Note: Although it may seem odd that this lesson suggestion is written for a very broad age group, the nature of the Digital Technologies curriculum and the suggestion itself allow for the tailoring of ideas to suit particular achievement levels. Through scaffolding and differentiation, the lesson can easily be adjusted to suit any of the above year levels.

**Years 3 and 4:**

***Knowledge and understanding:***

- Identify and explore a range of digital systems with peripheral devices for different purposes, and transmit different types of data (ACTDIK007)

***Processes and production skills:***

- Collect, access and present different types of data using simple software to create information and solve problems (ACTDIP009)
- Define simple problems, and describe and follow a sequence of steps and decisions (algorithms) needed to solve them (ACTDIP010)
- Implement simple digital solutions as visual programs with algorithms involving branching (decisions) and user input (ACTDIP011)
- Explain how student solutions and existing information systems meet common personal, school or community

needs (ACTDIP012)

- Plan, create and communicate ideas and information independently and with others, applying agreed ethical and social protocols (ACTDIP013)

**Years 5 and 6:**

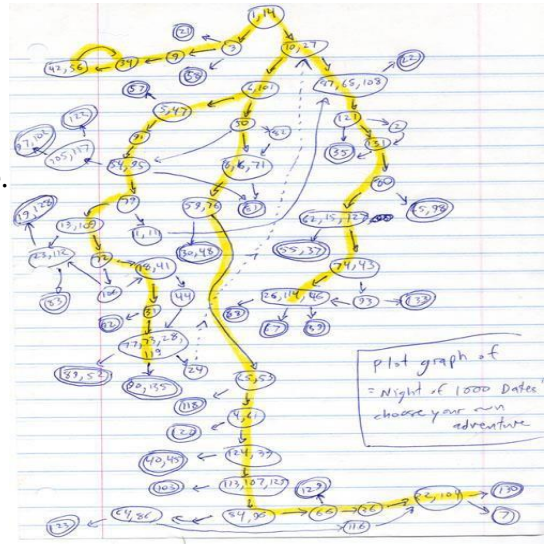
***Knowledge and understanding:***

- Examine the main components of common digital systems and how they may connect together to form networks to transmit data (ACTDIK014)

***Processes and production skills:***

- Acquire, store and validate different types of data, and use a range of software to interpret and visualise data to create information (ACTDIP016)
- Define problems in terms of data and functional requirements drawing on previously solved problems (ACTDIP017)
- Design a user interface for a digital system (ACTDIP018)
- Design, modify and follow simple algorithms involving sequences of steps, branching, and
- iteration (repetition) (ACTDIP019)
- Implement digital solutions as simple visual programs involving branching, iteration (repetition), and user input (ACTDIP020)
- Explain how student solutions and existing information systems are sustainable and meet current and future local community needs (ACTDIP021)
- Plan, create and communicate ideas and information, including collaboratively online, applying agreed ethical, social and technical protocols (ACTDIP022)

**Teaching suggestions and links to the curriculum:**




As students interact with the Digital Technologies curriculum, they are given opportunities and pathways to develop computational thinking through the digital design of interactive adventures that involve user choice. This is a wonderful opportunity to deeply engage students in other content learning by allowing them to present their learning through the creation of their own interactive games.

It would be a great idea to allow students to explore and share information about Flying Foxes and Microbats through interactive games, stories or educational apps created in software such as PowerPoint or online coding sites such as Scratch (https://scratch.mit.edu/).

Have students create an interactive PowerPoint by first planning and drawing a branch diagram with a series of 'if, then' sequences. Once this is created, these sequences can be transferred into PowerPoint using Hyperlinks between slides. Simple instructions on how to create these links can be found at (http://www.wikihow.com/Create-a-Computer-Game-

Using-PowerPoint).

Using these links, your students may choose to create a game which asks the player a series of questions and takes them on an 'adventure'. Through their questions and answers, your students can show not just what they have learnt about Flying Foxes and Microbats, but also show that they understand the consequence of certain actions. For instance, students may create a scenario such as:

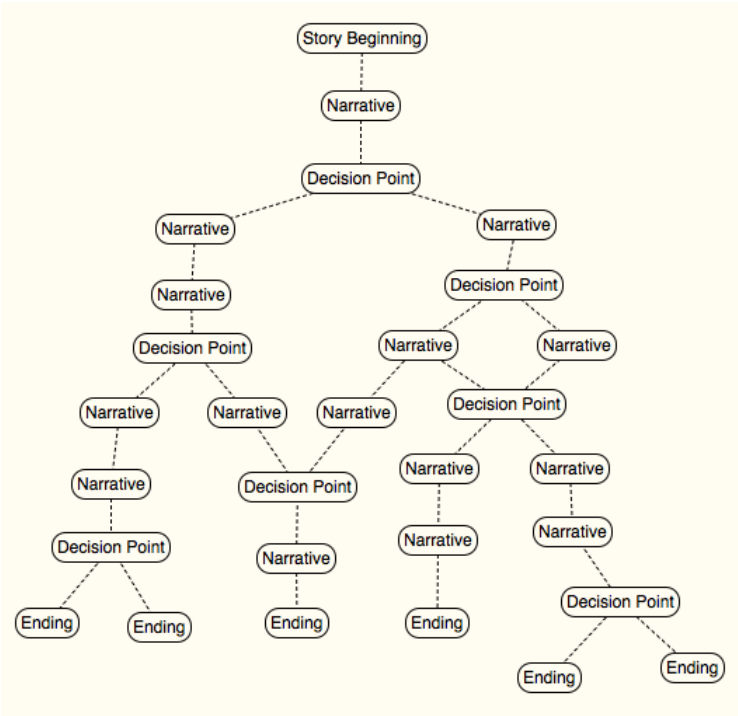
> "You are a farmer who grows various fruits such as apple, pear and plum trees. You are having trouble with fruit flies that keep attacking all your fruit. A friend suggests you install bat boxes to encourage Microbats to roost in your area. Your friend explain that the Microbats will eat the fruit flies and help you with your problem. You always hear bad stories about bats in the news and think maybe it is just better to use pesticides. Do you:
>
> a. Trust your instincts and buy a huge amount of pesticides
> b. Trust your friend and install bat boxes"

Each scenario will then lead the reader to a consequence. Answer 'a' will offer a negative consequence, answer 'b' will lead to a positive response.

Alternatively, students may create a question and answer game where the player is testing their knowledge to gain the title of "Bat Warrior". Each time the player answers a multiple choice or true/false question correctly, the player advances to the next question. If the answer is incorrect, they receive a message saying "Oh, no! You are not a great Bat Warrior. Try again." The player will then be given the option to begin the game again.

Of course, these are just several suggestions that students could create. However, ideas should be left to the imagination of students through collaborative brainstorming sessions. PowerPoint can also offer a fantastic way to integrate English with Digital Technology by asking students to create a "Choose Your Own Adventure" story. You may read books such as Stellaluna by Pamela Reed or Bangu the Flying Fox as retold by Janell Cannon with your students. These books offer a story told from the perspective of a Flying Fox. Have your students create a similar story or tell these stories from another character's perspective and present it as a Choose Your Own Adventure story in PowerPoint.

Finally, online coding sites such as Scratch can offer another great platform for your students to present their learning about Flying Foxes and Microbats. Your students can create a mini-game where the player is a Microbat who must progress through levels by eating insects. The opportunities are endless and offer a great way to allow students to integrate their creative and critical thinking with digital technology.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